U.S. Department of Energy
Technical Qualification Program

Radiation Protection Topical Area

Study Guide

Appendix
Glossary

DRAFT
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Administrative Control Level	A numerical dose constraint established at a level below the regulatory limits to administratively control and help reduce individual and collective dose.
Airborne Radioactive Material or Airborne Radioactivity	Radioactive material in any chemical or physical form that is dissolved, mixed, suspended, or otherwise entrained in air.
Airborne Radioactivity Area	Any area where the measured concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed 10 percent of the derived air concentration (DAC) values listed in appendix A or appendix C of 10 CFR 835.
Annual Limit on Intake (ALI)	The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man (ICRP 23) that would result in a committed effective dose equivalent of 5 rem (0.05 sievert [Sv]) or a committed dose equivalent of 50 rem (0.5 Sv) to any individual organ or tissue.
As Low As Reasonably Achievable (ALARA)	The approach to radiation protection to manage and control exposures (individual and collective) to the work force and to the general public at levels as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. As used in 10 CFR 835, ALARA is not a dose limit but a process that has the objective of attaining doses as far below the applicable limits of 10 CFR 835 as is reasonably achievable.
Assessment	Evaluation or appraisal of a process, program, or activity to estimate its acceptability.
Background Radiation	Radiation from: (1) Naturally-occurring radioactive materials which have not been technologically enhanced; (2) Cosmic sources; (3) Global fallout as it exists in the environment (such as from the testing of nuclear explosive devices);

Background Radiation (cont.)	(4) Radon and its progeny in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities; and (5) Consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation.
Best Available Technology (BAT)	BAT means the preferred technology for treating a particular process liquid waste, selected from among others taking into account factors related to technology, economics, public policy, and other parameters. BAT is not a specific level of treatment, but the conclusion of a selection process that includes several treatment alternatives.
Becquerel (Bq)	The International System (SI) unit for activity of radioactive material. One becquerel is that quantity of radioactive material in which one atom is transformed per second or undergoes one disintegration per second.
Bioassay	The determination of the kinds, quantities, or concentrations, and, in some cases, locations of radioactive material in the human body, whether by direct measurement or by analysis, and evaluation of radioactive materials excreted or removed from the human body.
Calibration	The process of adjusting or determining either: (1) The response or reading of an instrument relative to a standard (e.g., primary, secondary, or tertiary) or to a series of conventionally true values; or (2) The strength of a radiation source relative to a standard (e.g., primary, secondary, or tertiary) or conventionally true value.
Containment Device	Barrier such as a glovebag, glovebox or tent for inhibiting the release of radioactive material from a specific location.
Contamination Area	Any area where contamination levels are greater than the values specified in appendix D of 10 CFR 835, but less than or equal to 100 times those levels.

Contamination Reduction Corridor — A defined pathway though a hazardous waste site contamination reduction zone where decontamination occurs.

Continuing Training — Training scheduled over a specified time such as over a two-year period for the purpose of maintaining and improving technical knowledge and skills.

Continuous Air Monitor (CAM) — Instrument that continuously samples and measures the levels of airborne radioactive materials on a "real-time" basis and has alarm capabilities at preset levels.

Controlled Area — Any area to which access is managed in order to protect individuals from exposure to radiation and/or radioactive material. Individuals who enter only the controlled area without entering radiological areas are not expected to receive a total effective dose equivalent of more than 100 mrem (0.001 Sv) in a year.

Decontamination — Process of removing radioactive contamination and materials from personnel, equipment or areas.

Derived Air Concentration (DAC) — For the radionuclides listed in appendix A of 10 CFR 835, the airborne concentration that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2,000 hours (assuming a breathing volume of 2,400 m^3). For radionuclides listed in appendix C of 10 CFR 835, the air immersion DACs were calculated for a continuous, non-shielded exposure via immersion in a semi-infinite atmospheric cloud. The value is based upon the derived airborne concentration found in Table 1 of the U. S. Environmental Protection Agency's Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, published September 1988.

Derived Concentration Guide (DCG) — DCG is the concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 mrem, 0.1 rem (1 mSv). DCGs do not consider decay products when the parent radionuclide is the cause of the exposure.

Disintegration per Minute (dpm)	The rate of emission by radioactive material as determined by correcting the counts per minute (cpm) observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
DOE Activity	An activity taken for or by the DOE that has the potential to result in the occupational exposure of an individual to radiation or radioactive material. The activity may be, but is not limited to, design, construction, operation, or decommissioning. To the extent appropriate, the activity may involve a single DOE facility or operation or a combination of facilities and operations, possibly including an entire site.
DOELAP	Department of Energy Laboratory Accreditation Program for personnel dosimetry.

Dose

The amount of energy deposited in body tissue due to radiation exposure. Various technical terms, such as dose equivalent, effective dose equivalent and collective dose, are used to evaluate the amount of radiation an exposed worker receives. These terms are used to describe the differing interactions of radiation with tissue as well as to assist in the management of personnel exposure to radiation.

Some types of radiation, such as neutron and alpha, deposit their energy more densely in affected tissue than gamma radiation and thereby causing more damage to tissue. The term **dose equivalent**, measured in units of rem, is used to take into account this difference in tissue damage. Therefore 1 rem from gamma radiation causes damage **equivalent** to 1 rem from alpha radiation. However, it takes one-twentieth as much energy from alpha radiation, as compared with gamma radiation, to produce this 1 rem **dose equivalent**.

Definitions for dose terms necessary for various exposure calculations and recordkeeping purposes include the following:

Absorbed Dose (D) The energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray [Gy]) (1 rad = 0.01 Gy).

Collective Dose	The sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-Sv).
Committed Dose Equivalent ($H_{T,5O}$)	The dose equivalent calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. lt does not include contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or Sv).
Committed Effective Dose Equivalent ($H_{E,5O}$)	The sum of the committed dose equivalents to various tissues in the body ($H_{T,50}$), each multiplied by the appropriate weighting factor (W_T)--that is, $H_{E,50} = \sum W_T H_{T,50}$. Committed effective dose equivalent is expressed in units of rem (or sievert).
Cumulative Total Effective Dose Equivalent	The sum of the total effective dose equivalents recorded for an individual for each year of employment at a DOE or DOE contractor site or facility, effective January 1, 1989.
Deep Dose Equivalent	The dose equivalent derived from external radiation at a tissue depth of 1 centimeter (cm) in tissue.
Dose Equivalent (H)	The product of the absorbed dose (D) in rad (or Gy) in tissue, a quality factor (Q), and other modifying factors (N). Dose equivalent is expressed in units of rem (or Sv) (1 rem = 0.01 Sv).

Effective Dose Equivalent (H_E)	The summation of the products of the dose equivalent received by specified tissues of the body (H_T) and the appropriate weighting factors (W_T)--that is, $H_E = \sum W_T H_T$. It includes the dose from radiation sources internal and/or external to the body. The effective dose equivalent is expressed in units of rem (or sievert).
External Dose or Exposure	That portion of the dose equivalent received from radiation sources (e.g., "external sources") outside the body.
Internal Dose or Exposure	That portion of the dose equivalent received from radioactive material taken into the body (e.g., "internal sources").
Lens of the Eye Dose Equivalent	The external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 cm.
Quality Factor	The principal modifying factor used to calculate the dose equivalent from the absorbed dose; the absorbed dose (expressed in rad or Gy) is multiplied by the appropriate quality factor (Q).
Shallow Dose Equivalent	The dose equivalent deriving from external radiation at a depth of 0.007 cm in tissue.
Total Effective Dose Equivalent (TEDE)	The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). For purposes of compliance with 10 CFR 835, deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures.

	Weighting Factor (W_T)	The fraction of the overall health risk, resulting from uniform, whole body irradiation, attributable to specific tissue (T). The dose equivalent to tissue, T, is multiplied by the appropriate weighting factor to obtain the effective dose equivalent contribution from that tissue.
	Whole Body	For the purposes of external exposure, head, trunk (including male gonads), arms above and including the elbow, or legs above and including the knee.
Dose Assessment	Process of determining radiological dose and uncertainty included in the dose estimate, through the use of exposure scenarios, bioassay results, monitoring data, source term information and pathway analysis.	
Embryo/Fetus	Developing human organism from conception until birth. Same as unborn child.	
Engineering Controls	Use of components and systems to reduce airborne radioactivity and the spread of contamination by using piping, containments, ventilation, filtration or shielding.	
Entrance or Access Point	Any location through which an individual could gain access to areas controlled for the purposes of radiation protection. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.	
Extremity	Hands and arms below the elbow or feet and legs below the knee.	

Facility	A facility includes systems, buildings, utilities, and related activities whose use is directed to a common purpose at a single location. Example include: accelerators, storage areas, test loops, nuclear reactors, radioactive waste disposal systems and burial grounds, testing laboratories, research laboratories, and accommodations for analytical examinations of components. Also includes: pipelines, ponds, impoundments, landfills and the like, and motor vehicles, rolling stock, and aircraft.
Fixed Contamination	Radioactive material that cannot be readily removed from surfaces by nondestructive means, such as casual contact, wiping, brushing or laundering.
Frisk or Frisking	Process of monitoring personnel for contamination. Frisking can be performed with hand-held survey instruments, automated monitoring devices or by a Radiological Control Technician (RCT).
Gray (Gy)	SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule (J) per kilogram (kg) (100 rad).
High-Efficiency Particulate Air (HEPA) Filter	Throwaway extended pleated medium dry-type filter with (1) a rigid casing enclosing the full depth of the pleats, (2) a minimum particle removal efficiency of 99.97 percent for thermally generated monodisperse di-octyl phlalate smoke particles with a diameter of 0.3 micrometer, and (3) a maximum pressure drop of 1.0 inch w.g. when clean and operated at its rated airflow capacity.
High Contamination Area	Any area where contamination levels are greater than 100 times the values specified in appendix D of 10 CFR 835.
High Radiation Area	Any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 Sv) in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.
Hot Particle	Fuel, activated corrosion product, or other particles of small size that have a high specific activity as a result of nuclear fission or neutron activation.

Hot Spot	Localized source of radiation or radioactive material normally within facility piping or equipment. The radiation levels of hot spots exceed the general area radiation level by more than a factor of 5 and are greater than 100 mrem (1 mSv) per hour on contact.
Infrequent or First-Time Activities	Radiological work activities or operations that require special management attention and consideration of new or novel radiological controls. The designation of infrequent or first-time activities is specifically applicable to facilities that conduct routine and recurring process operations, and is not applicable to facilities that routinely conduct first-time activities, such as experimental or research facilities.
Irradiator	Sealed radioactive material used to irradiate other materials that has the potential to create a radiation level exceeding 500 rad (5 Gy) in 1 hour at 1 meter.
Lifetime Dose	Total occupational exposure over a worker's lifetime, including external and committed internal dose.
Low-Level Waste	Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, spent nuclear fuel or byproduct material as defined in Section 1le(2) of the Atomic Energy Act, as amended. Test specimens of fissionable material irradiated only for research and development and not for production of power or plutonium may be classified as low-level waste provided the concentration of transuranic activity is less than 100 nCi/g.
Mixed Waste	Waste containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act (RCRA), respectively.

Monitoring — Actions intended to detect and quantify radiological conditions.

- **Effluent Monitoring** — is the collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, and demonstrating compliance with applicable standards.
- **Environmental Surveillance** — is the collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures of members of the public, and assessing effects, if any, on the local environment.

Nonstochastic Effects — Effects due to radiation exposure for which the severity varies with the dose and for which a threshold normally exists (e.g., radiation-induced opacities within the lens of the eye).

Nuclear Criticality — A self-sustaining chain reaction, i.e., the state in which the effective neutron multiplication constant of system of fissionable material equals or exceeds unity.

Occupational Exposure — An individual's exposure to ionizing radiation (external and internal) as a result of that individual's work assignment. Occupational exposure does not include planned special exposures, exposure received as a medical patient, background radiation, or voluntary participation in medical research programs.

Personnel Dosimetry — Devices designed to be worn by a single person for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), and pocket ionization chambers.

Personnel Monitoring	Systematic and periodic estimate of radiation dose received by personnel during working hours. Also, the monitoring of personnel, their excretions, skin or any part of their clothing to determine the amount of radioactivity present.
Personal Protective Equipment	Equipment such as respirators, face shields and safety glasses used to protect workers from excessive exposure to radioactive or hazardous materials.
Planned Special Exposure	Preplanned, infrequent exposure to radiation, separate from and in addition to the annual dose limits.
Prefilter	Filter that provides first stage air filtration to remove larger particulates and prolong the efficient use of a HEPA filter.
Primary Dosimeter	A dosimeter worn on the body used to obtain the formal record of whole body radiation dose.
Protective Clothing	Clothing provided to personnel to minimize the potential for skin, personal and company issued clothing contamination. Also referred to as "anticontamination clothing," "anti-Cs" and "Pcs."
Public	Any individual or group of individuals who is not occupationally exposed to radiation or radioactive material. An individual is not a "member of the public" during any period in which the individual receives an occupational exposure.
Qualification Standard	The explicit performance requirements for minimum proficiency in technical, academic, and site-specific knowledge and practical skills used in determining satisfactory completion of training programs. The qualification standard is used to qualify RCTs at DOE facilities.
Rad	Unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs per gram or 0.01 joules per kilogram (0.01 Gy).
Radiation or Ionizing Radiation	Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions.

Radiation Area	Any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (0.05 mSv) in one hour at 30 cm from the radiation source or from any surface that the radiation penetrates.
Radioactive Material	Radioactive material includes any material, equipment, or system component determined to be contaminated or suspected of being contaminated. Radioactive material also includes activated material, sealed and unsealed sources, and material that emits radiation.
Radioactive Material Area	An area or structure where radioactive material is used, handled, or stored.
Radioactive Waste	Solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act, as amended, and is of negligible economic value considering the cost of recovery.
Radioactivity	A natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy from their nuclei and, thus, change (or decay) to atoms of a different element or to a lower energy state of the same element.
Radiography	Examination of the structure of materials by nondestructive methods, using a radioactive source or a radiation-generating device.
Radiological Area	Any area within a controlled area which must be posted as a "radiation area," "high radiation area," "very high radiation area," "contamination area," "high contamination area," or "airborne radioactivity area" in accordance with 10 CFR 835.603.
Radiological Buffer Area (RBA)	An intermediate area established to prevent the spread of radioactive contamination and to protect personnel from radiation exposure.
Radiological Label	Label on an item which indicates the presence of radiation or radioactive materials.
Radiological Posting	Sign, marking, or label that indicates the presence or potential presence of radiation or radioactive materials.

Radiological Work	Any work that requires the handling of radioactive material or which requires access to a "radiation area," "high radiation area," "very high radiation area," "contamination area," "high contamination area," or "airborne radioactivity area" in accordance with 10 CFR 835.
Radiological Work Permit (RWP)	Permit that identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals for radiological work activities. The Radiological Work Permit serves as an administrative process for planning and controlling radiological work and informing the worker of the radiological conditions.
Radiological Worker	A general employee whose job assignment involves operation of radiation-producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 0.1 rem (0.001 Sv) per year total effective dose equivalent.
Reference Man	Reference man means a hypothetical aggregation of human (male and female) physical and physiological characteristics arrived at by international consensus (ICRP 23). These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult from ionizing radiation to a common base. The "reference man" is assumed to inhale 8,400 cubic meters of air in a year and to ingest 730 liters of water in a year.
Refresher Training	Training scheduled on the alternate year when full retraining is not completed for Radiological Worker I and Radiological Worker II personnel.
Release to Uncontrolled Areas	Release of material from administrative control after confirming that the residual radioactive material meets the guidelines in DOE Order 5400.5.
Rem	Unit of dose equivalent. Dose equivalent in rem is numerically equal to the absorbed dose in rad multiplied by a quality factor, distribution factor and any other necessary modifying factor (1 rem = 0.01 Sv).

Remedial Action	Remedial action means those actions consistent with permanent remedy release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment.
Removable Contamination	Radioactive material that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing or washing.
Representative Sample	A sample that closely approximates both the concentration of activity and the physical and chemical properties of material (e.g., particle size and solubility in case of air sampling of the aerosol to which workers may be exposed).
Respiratory Protective Equipment	Equipment used to protect personnel from inhalation of radioactive or hazardous materials.
Sievert (Sv)	SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rem).
Site	An area managed by DOE where access can be limited for any reason. The site boundary encompasses Controlled Areas.
Sealed Radioactive Source	Radioactive material that is contained in a sealed capsule, sealed between layer(s) of nonradioactive material, or firmly fixed to a nonradioactive surface by electroplating or other means. The confining barrier prevents dispersion of the radioactive material under normal and most accidental conditions related to use of the source.
Standard Radiation Symbols	Symbols designed and proportioned as illustrated in accordance with ANSI N2. 1 for radiation symbols and ANSI N12.1 for fissile material.
Soil Column	Soil column is an in situ volume of soil down through which liquid wastes percolate from ponds, cribs, seepage basins, or trenches.

Stochastic Effects	Malignant and hereditary diseases for which the probability of an effect occurring, rather than its severity, is regarded as a function of dose without a threshold for radiation protection purposes.
Survey	An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.
Thermoluminescent Dosimeter (TLD)	Radiation monitoring device used to record the radiological exposure of personnel or areas to certain types of radiation.
Transuranic Waste	Without regard to source or form, waste that is contaminated with alpha-emitting transuranic radionuclides having half-lives greater than 20 years and concentrations greater than 100 nCi/g at the time of assay.
Unusual Occurrence	Nonemergency occurrence that has significant impact or potential for impact on safety, environment, health, security, or operations. Examples of the types of occurrences that are to be categorized as unusual occurrences are contained in DOE 5000.3A.
Very High Radiation Area	Any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rad (5 Gy) in one hour at 1 meter from a radiation source or from any surface that the radiation penetrates.
Visitor	Person requesting access to Controlled Areas who has not been trained to the level required to permit unescorted access.
Whole Body Dose	The sum of the annual deep dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.

Year The period of time beginning on or near January 1 used to determine compliance with the provisions of 10 CFR 835. The starting date of the year used to determine compliance may be changed provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.